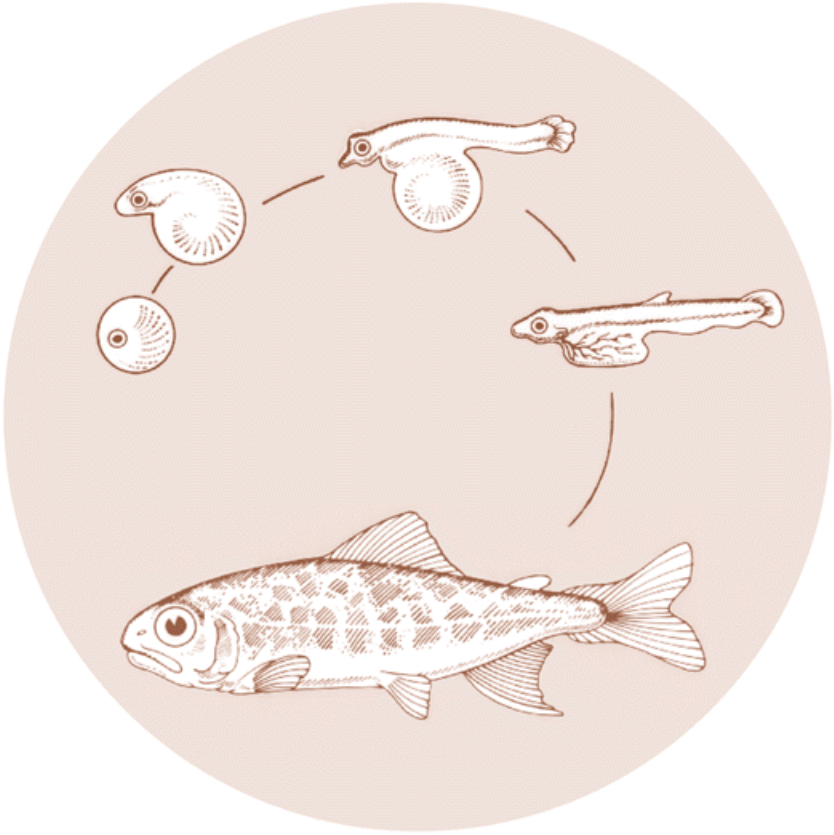
AUGMENED FISH HEALTH MONITORING FOR THE WASHINGTON DEPARTMENT OF WILDLIFE

Annual Report 1989



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AUGMENTED FISH HEALTH MONITORING

Annual Report 1989

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Project No. 86-13
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Introduction

The augmented fish health monitoring project is funded by the Bonneville Power Administration (BPA) with the mandate to collect fish health data on anadromous fish stocks of the BPA Columbia River Basin in a standardized manner. The project began in 1986 and the data reported here was collected in the fourth year. This segment of the project was carried out by the Washington Department of Wildlife and summarizes fish health findings at anadromous game fish hatcheries in Washington State operated by the BPA.

Information gathered to date has provided impetus to alter facility design and management practices for improved fish health through prevention. Treatment efficacy can be better assessed due to the monthly monitoring of fish stocks and insight is being gained into disease prevention and control. The ultimate goal, of course, is to improve fish health for better survival in the wild. Tagged returns at index hatcheries within this project area will provide some indication of the impact of improving fish health on providing greater adult returns as well as an improved product for the fishery.

Description of Study Area

This project was designed to collect and summarize anadromous fish health related data from Washington Department of Wildlife facilities in the Columbia River drainage. Washington Department of Wildlife rears winter run steelhead, summer run steelhead, and sea run cutthroat trout in these facilities though not all three species and/or all strains are raised at every facility. Location of the facilities and rearing programs are indicated on Figure 1 and Table 1.

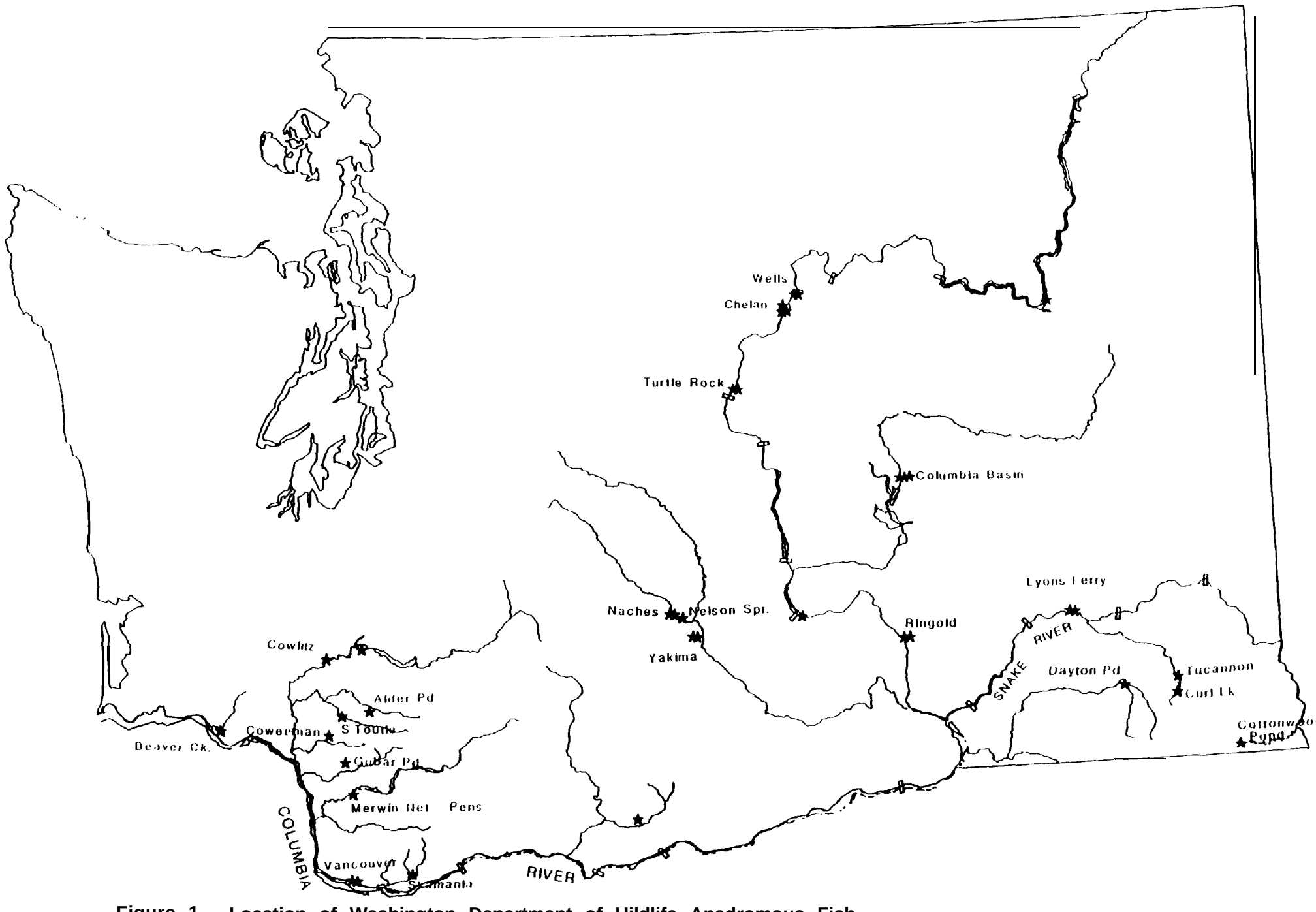


Figure 1. Location of Washington Department of Uildlife Anadromous Fish Production Facilities in the Columbia River Drainage

Table 1. WDW Columbia River Drainage Anadromous Fish Rearing Programs

Installation	Drainage	Annual Program/ Transfers to
Beaver Ck. Hatchery	Elochoman	Winter SH Smolts. Winter SH Pre-smolts for Coweeman and Gobar. Summer SH Smolts. Searun CT Smolts. Searun CT Pre-smolts for Coweeman and Skamania. Two Broodstocks.
Coweeman SH Pond	Coweeman	Winter SH Smolts.
Coweeman CT Pond	Coweeman	Searun CT Somots.
Alder Creek Pond	N. Fork Toutle	Summer SH Smolts.
South Toutle Trap	S. Fork Toutle	Winter SH Parr,
Cowlitz Hatchery	Cowlitz	Winter SH Smolts. Summer SH Smolts. Searun CT Smolts. Three Broodstocks.
Gobar Pond	Kalama	Winter SH Smolts. Summer SH Smolts.
Merwin Net Pens	Lewis	Summer SH Smolts.
Vancouver Hatchery	L. Columbia	Summer SH Smolts. Summer SH Fingerlings for Skamania. Winter SH Fingerlings for Skamania.
Skamania Hatchery	Washougal	Winter SH Smolts. Summer SH Smolts Summer SH Pre-smolts for Alder Ck., Gobar and Merwin. Three Broodstocks.
Yakima Hatchery	Yakima	Summer SH Smolts. One Broodstock.
Nelson Springs Raceway	Naches	Summer SH Smolts.

Table 1 (Continued). WDW Columbia River Drainage Anadromous Fish Rearing Programs

Installation	Drainage	Annual Program/ Transfers to
Naches Hatchery	Naches	Summer SH Fingerlings for Nelson Spring.
Ringold Pond	Upper Columbia	Summer SH Smolts.
Columbia Basin Hatchery	Crab Creek	Sumer SH Fingerlings for Ringold Pond.
Turtle Rock Pond	Upper Columbia	Summer SH Smolts.
Chelan Hatchery	Upper Columbia	Summer SH Smolts. Summer SH Fingerlings for Turtle Rock. One Broodstock.
Wells Hatchery	Upper Columbia	Summer SH Smolts. One Broodstock.
Lyons Ferry Hatchery	Lower Snake	Summer SH Smolts. Summer SH Pre-smolts. for Cottonwood, Curl and Dayton Ponds.
Cottonwood Pond	Grand Ronde	Summer SH Smolts.
Curl Lake	Tucannon	Summer SH Smolts.
Dayton Pond	Touchet	Summer SH Smolts.

SH = Steelhead
CT = Cutthroat

Materials and Methods

Materials and methods were described in Augmented Fish Health Monitoring for Washington Department of Wildlife; 1986. Annual Report (Gearheard et al, 1987).

Results and Discussion

Objective 1.0 Complete Start-up Phase.

Task 1.1 Acquire Competent Staff.

The project staff remained the same as reported for 1988.

Current project staff are:

Project Leader:	John Kerwin
Fish Pathologists:	Steve Roberts
	Leni Oman
Fish Biologists:	Bruce Bolding

Objective 2.0 Serve on technical steering committee.

Task 2.1 Technical Steering Committee.

Two meetings of the Project Technical Steering committee were held. The first meeting was held at the Best Western Twin in Falls, Idaho on October 17-18, 1989 and attended by John Kerwin, Leni Oman, and Steve Roberts. The second meeting was held at the East bank Hatchery in Wenatchee, Washington on April 25-26, 1990. John Kerwin and Steve Roberts represented WDW at this meeting. Current project progress, IHNV vaccine trials, Renibacterium salmoninarum assay methods, and interpretation and modification of project tasks were discussed at all meetings.

Task 2.2 Technology transfer.

WDW has distributed the 1988 Annual Report to appropriate personnel within the Agency and to the Washington State Library. BPA distributed the publication to other interested parties.

Significant findings are also reported in the WDW fish hatchery newsletter, The Leaky Boot, which is distributed within the agency as well as to the editors of the Anal Fin, the U.S. Fish and Wildlife Service Hatchery newsletter.

Task 2.3 Facility impediments.

This task was detailed in the 1987 Annual Report (Gearheard et al, 1987).

Task 3.1 Organosomatic Analysis at "Index" Hatcheries.

The organosomatic analysis, based on Goede's method (Ron Goede, 1988), is designed to quantify departures from a physically "normal" condition in a population of fish. It is not a diagnostic tool, but useful as an indicator of trends in fish condition. The analysis in this study was performed at or close to the smolt stage in conjunction with preliberation exams at "Index" hatcheries (Table 2.).

The overall condition of the smolts at Wells Hatchery was better in all categories than the smolts at the Cowlitz Hatchery. This determination was based on the percent of fish that were closer to normal on the organosomatic index. The fish at Wells were longer, heavier, with a better condition factor and a higher average hematocrit level. In addition, the Wells fish had a greater pyloric fat level, which is desirable at the smolt stage, and all the internal organs were considered normal. In contrast, the fish at Cowlitz had varying degrees of abnormality, such as enlarged spleens, hind guts and kidneys, or pale kidneys and gills. The less desirable condition of the fish at the Cowlitz hatchery was directly attributed to the numbers of the protozoan parasite Ceratomyxa Shasta in the intestinal tract of the fish. The pathological signs listed above are classic for C. Shasta infections. The parasite was found in all production lots at Cowlitz and has been implicated as the causative agent in the loss of up to 80% of some production lots there. Tables 3 and 4 list the comparative data for all stocks examined with the organosomatic index.

A comparison of the 1989 data with that of the previous three years shows almost no change in the Wells summer steelhead. The size and condition of the fish are almost identical. The four stocks of fish examined at the Cowlitz, however, display different values from last year in all measured categories. The size variation may be attributed to the different time of examination of the fish from the previous year (though samples were gathered within four weeks of the previous year); or, the severity of Ceratomyxosis this year may have caused stunting due to the poor appetite in affected fish. In addition, the index values for internal organs varied from last year; this may also be attributed to Ceratomyxosis in the fish during all three years of the project.

The organosomatic index was helpful in documenting the chronic problem of C. Shasta at Cowlitz and continued use of this evaluation will help document effects of an ozone treatment facility to be installed by Tacoma City Light for control of Ceratomyxosis.

Task 3.2 Test for Specific Pathogens

Viral Pathogens

Standard techniques were employed to assay all samples taken for the project (Gearheard et al., 1987). Assays for replicating viral agents, specifically infectious hematopoietic necrosis virus viral hemorrhagic septicemia virus (IHNV) and infectious pancreatic necrosis virus (IPNV), were carried out under an interagency subcontract with the Washington Department of Fisheries (WDF) virology lab. Assays revealed that nine stocks of steelhead broodfish at four hatcheries had detectable levels of IHNV (Table 5) though no mortality was attributed to viremia in these returning adults. Infectious pancreatic necrosis virus was not detected in broodfish at the Wells Hatchery during 1989. This follows two years of positive results in Wells summer steelhead stocks. Assays for erythrocytic inclusion body syndrome virus (EIBSV) were carried out by WDW staff. A 5% incidence of the virus was detected in summer steelhead broodfish at Wells. Assays of all other stocks were negative for the virus (Table 5).

Cell culture assays on 1989 smolt samples were negative for replicating viral agents (Table 6). Beaver Creek searun cutthroat smolts had a 3% incidence of EIBS (Table 6). Viral monitoring of the 1990 smolt releases revealed IHNV present in four stocks of fish at two hatcheries and EIBS present in five stocks of fish at five hatcheries (Table 7). At the Skamania Hatchery, smolts developed clinical signs of IHN and an increase in mortality was attributed to viremia. Fish losses are reported under Task 6.1.3. and Table 15.

Juvenile fish at Lyons Ferry and Skamania Hatcheries experienced IHN epizootics during June and July, 1989. Details are reported under Task 6.1.3 and Table 15.

Bacterial Pathogens

Assays for Renibacterium salmoninarum, the causative agent of bacterial kidney disease (BKD) were conducted and the BPA guidelines for determination of positive samples were utilized. One positive broodstock was found at each of two hatcheries (Figure 2 and Table 8). Both stocks had a prevalence of two percent. Assays for the bacterium on 1989 samples, gathered during the preliberation exam, were lightly positive in two stocks of fish at two hatcheries (Table 9). Searun cutthroat from Coweeman Pond and summer steelhead from Wells Hatchery each had a two percent incidence of R. salmoninarum. Assays performed on searun cutthroat samples taken during midterm monitoring from Cowlitz, Skamania, and Beaver Creek Hatcheries were free of the bacterium (Table 10).

Parasitic Pathogens

All samples for Myxobolus cerebralis processed were negative for the parasite (Table 11). Ceratomyxa Shasta continues to cause significant losses in production lots at the Cowlitz hatchery, our only site which is plagued by the parasite. An ozone water treatment plant is being installed to attempt to control the ceratomyxosis. The system will be on line in June 1991. The causative agent of proliferative kidney disease (PKX) was not detected during routine necropsy and clinical signs of the disease were not observed.

Objective 4.0 Monitoring Hatchery Water Supplies.

Task 4.1 Sample Hatchery Water Supplies.

A sampling plan was completed in the 1986 annual report (Gearheard et al, 1987). WDW is awaiting the selection of a water testing laboratory by BPA.

Task 4.3 Monitoring Flow and Loading Densities.

Flow loading index and density loading index data were collected for all WDW Columbia River anadromous fish hatcheries. The data was collected and entered into a Lotus l-2-3 worksheet for flow and density index calculation for each pond of fish within each lot of fish. The data has been summarized for the 1988 broodyear and is contained in Table 12.

Objective 5.0 Record, Analyze and Report Fish Health Monitoring and Related Data.

Currently, monthly monitoring data and specific pathogen testing information has been entered into a dbase III+ database. The flow and density data has been entered into Lotus l-2-3 worksheets for each facility.

Objective 6.0 Estimate the Project's Benefits.

Task 6.1.1 Severity of Pathogens and Mortality Caused.

Completed in 1986 annual report (Gearheard et al, 1987).

Task 6.1.2 Total Number and Percent Loss of Each Lifestage of Fish Species.

Lot Production Mortalities

Lot production data from WDW hatchery reports were entered into a Lotus l-2-3 worksheet. Calculations were made that include total number of fish and percentage loss for each facility.

The average egg mortality for the 1988 broodyear was 13.7% with a range of 5.4% at Chelan hatchery to 33% at Beaver Creek hatchery. The average fry mortality for the 1988 broodyear was 15.1% with a range of 0.9% at Skamania hatchery to 39.6% at Beaver Creek hatchery. The resulting egg and fry mortality yielded an overall average mortality from egg to smolt of 39.1%.

A summary of the egg and fry mortality for the 1988 broodyear is contained in Table 13.

Adult Prespawning Mortalities.

Adult prespawning mortality data from WDW hatchery reports were entered into a Lotus l-2-3 worksheet and are reported in Table 14.

Task 6.1.3 Number and Causative Agents of Epizootics, Type and Amount of Medication Used

Disease outbreaks causing significant mortality occurred at three WDW Columbia Basin hatcheries between July 1, 1987 and June 30, 1989. When possible, epizootics were treated with medication (Table 15).

Task 6.1.4 Feed Conversion

Data from WDW hatchery reports were entered into a Lotus l-2-3 worksheet. Calculations reflect total pounds of feed fed versus total pounds of fish produced or, i.e. feed conversion (Table 16).

Task 6.1.5 Total Survival of Smolts to Adults from Index Hatcheries

Work has not been completed on this task at this time.

Literature Cited

Gearheard, J., S. Roberts, D. Chase, B. Bolding, and Ron Goede. 1987. Augmented fish health monitoring for Washington Department of Wildlife, 1986 Annual Report. BPA Project No. 86-54.

Roberts, S., W. Brunson, and D. Chase. 1987. Pathology of fish diseases and promotion of fish health. Progress Report, D-J Project F-56-R-19. 44 pgs.

Goede, Ron. 1988 Fish Health/Condition Assessment Procedures. Utah Division of Wildlife Resources, Logan UT.

Acknowledgments

We would like to thank the Bonneville Power Administration for their financial support of this project as well as Washington Department of Wildlife hatchery managers and staff for providing valuable assistance in interpretation of records and collection of samples and data. We would also like to express our appreciation of Bill Eaton and the staff of the Washington Department of Fisheries virology laboratory, for their continuing efforts in testing collected samples for viral agents.

Tables

Table 2. List of "Index" Hatcheries, Species and Stocks in which Organosomatic Analysis was performed.

Hatchery	Species	Stock
Cowlitz	Summer Steelhead	Cowlitz
Cowlitz	Winter Steelhead	Cowlitz
Cowlitz	Sea-Run Cutthroat	Cowlitz
Wells	Summer Steelhead	Wells

Table 3. Organosomatic Index Results. Average Values, by Species and Stock, for Measured Parameters: Length, Weight, Condition Factor and Hematocrit with Standard Deviation.

Hatchery	Species	Length (mm)	SD	Weight (gm)	SD	Cond Fact	HCT	SD
Cowlitz	ss	162	16.8	42.5	15.2	0.69	37.0	
Cowlitz	SW	154	14.8	36.4	11.9	0.58	44.8	
Cowlitz	SW(late)	163	12.7	45.6	10.5	0.76	45.2	
Cowlitz	CT	173	26.7	56.1	21.2	1.03	39.1	
Wells	ss	198	16.7	72.7	19.1	0.94	57.0	6.7

Table 4. Values of Percentage of Population by Species/Stock/Hatchery of Individual Organs.

Winter Steelhead(late)/Cowlitz/Cowlitz

Score	Fat	Spleen	Hind Gut	Kidney	Liver	Gills
0	2%	30%	95%	100%	28%	100%
1	12%	70%	0%	0%	72%	
2	45%		0%	0%		
3	40%		5%	0%		
4	2%			0%		
5	0%			0%		

Winter Steelhead/Cowlitz/Cowlitz

0	53%	53%	35%	58%	35%	84%
1	40%	28%	47%	2%	50%	16%
2	6%	15%	18%	33%	2%	0%
3	0%	3%	0%	2%	2%	0%
4	0%	0%	0%	5%	7%	0%
5	0%	0%	0%	0%	3%	0%

Summer Steelhead/Cowlitz/Cowlitz

0	48%	17%	47%	98%	27%	88%
1	30%	48%	33%	2%	70%	12%
2	20%	3%	0%	0%		0%
3	0%	0%	0%	0%		0%
4	0%	0%	0%	0%		0%
5	0%	0%	0%	0%		0%

Sea-Run Cutthroat/Cowlitz/Cowlitz

0	2%	55%	77%	98%	15%	82%
1	15%	45%	22%	2%	83%	18%
2	28%	%	0%	0%	2%	0%
3	47%		2	0%	0%	0%
4	8%					
5						

Summer Steelhead/Wells/Wells

0	0%	100%	100%	100%	100%	100%
1	3%	0%	0%	0%	0%	0%
2	37%	0%	0%	0%	0%	0%
3	58%	0%	0%	0%	0%	0%
4	2%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%

A score of 0 = a normal condition with abnormality increasing numerically to 5 with the exception of fat values, where 2-3 is a desirable value.

Table 5. Results of Viral Assays: 1989-90 Broodstock.

Hatchery	Species	Stock	IPNV	IHNV	EIBS(% pos)
Beaver Creek	W. Steelhead	Elochoman	neg	neg	0
Beaver Creek	SR Cutthroat	Elochoman	neg	neg	0
Chelan	S. Steelhead	Ringold	neg	neg	0
Cowlitz	S. Steelhead	Cowlitz	neg	pos	0
Cowlitz	W. Steelhead	Cowlitz	neg	pos	0
Cowlitz	W. (late) Steelhead	Cowlitz	neg	pos	0
Cowlitz	SR Cutthroat	Cowlitz	neg	pos	0
Lyons Ferry	S. Steelhead	Lyons Ferry	neg	pos	0
Skamania	S. Steelhead	Skamania	neg	pos	0
Skamania	W. Steelhead	Washougal	neg	pos	0
Skamania	SR Cutthroat	Washougal	neg	pos	0
Wells	S. Steelhead	Wells	neg	neg	5
Yakima	S. Steelhead	Yakima	neg	neg	0

Table 6. Results of Viral Assays: 1989 Smolts.

Location	Species	Stock	IPNV	IHNV	EIBS(% pos)
Alder Cr. Pond	Not Stocked				
Beaver Cr.	S. Steelhead	Skamania	neg	neg	0
Beaver Cr.	W. Steelhead	Elochoman	neg	neg	0
Beaver Cr.	SR Cutthroat	Elochoman	neg	neg	3
Chelan	S. Steelhead	Wells	neg	neg	0
Cottonwood Pond	S. Steelhead	Wallowa	neg	neg	0
Coweeman Pond	W. Steelhead	Elochoman	neg	neg	0
Coweeman Pond	W. Steelhead	Elochoman	neg	neg	0
Cowlitz	S. Steelhead	Cowlitz	neg	neg	0
Cowlitz	W. Steelhead	Cowlitz	neg	neg	0
Cowlitz	S. (late) Steelhead	Cowlitz	neg	neg	0
Cowlitz	SR Cutthroat	Cowlitz	neg	neg	0
Curl Lake	S. Steelhead	L. Ferry	neg	neg	0
Dayton Pond	S. Steelhead	L. Ferry	neg	neg	0
Gobar Pond	S/W Steelhead	Skamania/ Elochoman	neg	neg	0
Lyons Ferry	S. Steelhead	L. Ferry	neg	neg	0
Merwin Net Pen	S. Steelhead	Skamania	neg	neg	0
Nelson Springs	S. Steelhead	Yakima	neg	neg	0
Ringold Pond	S. Steelhead	Ringold	neg	neg	0
Skamania	S. Steelhead	Skamania	neg	neg	0
Skamania	W. Steelhead	Washougal	neg	neg	0
Skamania	SR Cutthroat	Washougal	neg	neg	0
So. Toutle Trap	W. Steelhead	Toutle	neg	neg	0
Turtle Rock	S. Steelhead	Ringold	neg	neg	0
Vancouver	S. Steelhead	Skamania	neg	neg	0
Wells	S. Steelhead	Wells	neg	neg	0
Yakima	S. Steelhead	Yakima	neg	neg	0

NS = Not Sampled

Table 7. Analysis for Viral Pathogens: 1990 Smolts

Location	Species	Stock	IPNV	IHNV	EIBS(%pos)
Beaver Cr.	S. Steelhead	Skamania	neg	neg	0
Beaver Cr.	W. Steelhead	Elochoman	neg	neg	0
Beaver Cr.	SR Cutthroat	Elochoman	neg	neg	5
Chelan	S. Steelhead	Wells	neg	neg	2
Cottonwood Pond	S. Steelhead	Wallowa	neg	neg	0
Upper Coweeman	S. Steelhead	Elochoman	neg	neg	0
Pond	Sr Cutthroat	Elochoman	neg	neg	0
Lower Coweeman	W. Steelhead	Elochoman	neg	neg	0
Pond	SR Cutthroat	Elochoman	neg	neg	0
Cowlitz	S. Steelhead	Cowlitz	neg	neg	0
Cowlitz	W. Steelhead	Cowlitz	neg	pos	2
Cowlitz	W. (late) Steelhead	Cowlitz	neg	neg	0
Cowlitz	SR Cutthroat	Cowlitz	neg	neg	0
Curl Lake	S. Steelhead	Pahsimeroi	neg	neg	0
Dayton Pond	S. Steelhead	L. Ferry	neg	neg	0
East Bank	S. Steelhead	Wells	neg	neg	2
Gobar Pond	S/W. Steelhead	Elochoman	neg	neg	0
Lyons Ferry	S. Steelhead	Pahsimoroi	neg	neg	0
Merwin Net Pen	W. Steelhead	Elochoman	neg	neg	0
Nelson Springs	S. Steelhead	Yakima	neg	neg	0
Ringold Pond	S. Steelhead	Ringold	neg	neg	3
Nile Pond	S. Steelhead	Yakima	neg	neg	0
Skamania	S. Steelhead	Skamania	neg	pos	0
Skamania	S. Steelhead	Washougal	neg	pos	0
Skamania	SR Cutthroat	Washougal	neg	pos	0
so. Toutle Trap	S. Steelhead	Skamania	neg	neg	0
Vancouver	S. Steelhead	Skamania	neg	neg	0
Wells	S. Steelhead	Wells	neg	neg	0
Yakima	S. Steelhead	Yakima	neg	neg	0

Table 8. Results of *Renibacterium salmoninarum* assays: **1989-90** Broodstock.

Hatchery	Species	Stock	Result
Beaver Creek	W. Steelhead	Elochoman	0/60 = 0% pos
Beaver Creek	SR Cutthroat	Elochoman	1/60 = 2% pos
Chelan	S. Steelhead	Ringold	0/60 0% pos
Cowlitz	S. Steelhead	Cowlitz	1/60 = 2% pos
Cowlitz	W. Steelhead	Cowlitz	0/60 = 0% pos
Cowlitz	W. (late) Steelhead	Cowlitz	0/60 = 0% pos
Cowlitz	SR Cutthroat	Cowlitz	0/60 = 0% pos
Lyons Ferry	S. Steelhead	Lyons Ferry	0/60 = 0% pos
Skamania	S. Steelhead	Washougal	0/60 = 0% pos
Skamania	W. Steelhead	Washougal	0/60 = 0% pos
Skamania	SR Cutthroat	Washougal	0/60 = 0% pos
Wells	S. Steelhead	Wells	0/60 = 0% pos
Yakima	S. Steelhead	Yakima	0/12 = 0% pos

Table 9. Results of Renibacterium salmoninarum assays: 1989 Smolts.

Location	Species	Stock	Result
Alder Cr. Pond	Not Stocked		
Beaver Cr.	S. Steelhead	Skamania	0/60 = 0% pos
Beaver Cr.	W. Steelhead	Elochoman	0/60 = 0% pos
Beaver Cr.	SR Cutthroat	Elochoman	0/60 = 0% pos
Chelan	S. Steelhead	Wells	0/60 = 0% pos
Cottonwood Pond	S. Steelhead	Wallowa	0/60 = 0% pos
Coweeman Pond	W. Steelhead	Elochoman	0/60 = 0% pos
Coweeman Pond	SR Cutthroat	Elochoman	1/60 = 2% pos
Cowlitz	S. Steelhead	Cowlitz	0/60 = 0% pos
Cowlitz	W. Steelhead	Cowlitz	0/60 = 0% pos
Cowlitz	W. (late) Steelhead	Cowlitz	0/60 = 0% pos
Cowlitz	SR Cutthroat	Cowlitz	0/60 = 0% pos
Curl Lake	S. Steelhead	L. Ferry	0/60 = 0% pos
Dayton Pond	S. Steelhead	L. Ferry	0/60 = 0% pos
Gobar Pond	S/W Steelhead	Skamania/ Elochoman	0/60 = 0% pos
Lyons Ferry	S. Steelhead	L. Ferry	0/60 = 0% pos
Merwin Net Pen	S. Steelhead	Skamania	0/60 = 0% pos
Nelson Springs	S. Steelhead	Yakima	0/60 = 0% pos
Ringold Pond	S. Steelhead	Ringold	0/60 = 0% pos
Skamania	S. Steelhead	Skamania	0/60 = 0% pos
Skamania	W. Steelhead	Washougal	0/60 = 0% pos
Sksmania	SR Cutthroat	Washougal	0/60 = 0% pos
Turtle Rock	S. Steelhead	Ringold	0/60 = 0% pos
Vancouver	S. Steelhead	Skamania	0/60 = 0% pos
Wells	S. Steelhead	Wells	1/60 = 2% pos
Yakima	S. Steelhead	Yakima	0/60 = 0% pos

Table 10. Analysis of Samples for Myxobolus cerebralis

Location	River Drainage	Species/Stock	Date	Result
Beaver Creek	SR Cutthroat	Elochoman		O/60 = 0% pos
Cowlitz	SR Cutthroat	Cowlitz		O/60 = 0% pos

Table 11. Density and Flow Indexes for 1988 Broodyear Fish reared at WDW facilities.

Location	Species	Stock	BY	Pond Type	Water Temp.	Dens. Index lb/ft3/in Avg.	Dens. Index lb/ft3/in Min.	Dens. Index lb/ft3/in Max.	Flow Index lb/gpm/in Avg.	Flow Index lb/gpm/in Min.	Flow Index lb/gpm/in Max.
Lyons Ferry	ss	Wallowa	88	RP	51-53	0.01	0.01	0.02	0.87	1.22	4.52
Lyons Ferry	SS	Lyons F.	88	RP	51-53	0.01	0.00	0.02	1.02	1.66	3.21
Ringold	ss	Ringold	88	RP	52-59	0.02	0.02	0.12	0.65	0.28	1.32
Lyons Ferry	ss	Lyons F.	87	RP	52	0.01	0.00	0.02	0.90	0.34	1.49
Lyons Ferry	SS	Lyons F.	87	R	48-54	0.10	0.04	0.16	0.66	0.37	1.38
Columbia Basin	SS	Ringold	87	R	58	0.22	0.17	0.29	0.79	0.62	1.04
Lyons Ferry	SS	Wallowa	87	R	50-54	0.06	0.03	0.08	0.39	0.15	0.58
Turtle Rock	SS	Ringold	87	R	37-47	0.13	0.12	0.14	1.05	0.99	1.11
Chelan	ss	Wells	87	R	54-56	0.16	0.09	0.29	1.12	0.53	2.94
Chelan	ss	Ringold	87	R	54-56	0.15	0.05	0.27	0.88	0.33	1.54
Nelson Springs	SS	Yakima	87	R	49-51	0.31	0.24	0.37	1.41	1.37	1.51
Naches	ss	Yakima	87	R	52-59	0.36	0.10	0.59	1.39	0.85	1.90
Columbia Basin	SS	Skamania	87	R	58-60	0.19	0.06	0.30	0.70	0.22	1.06
Wells	ss	Wells	87	R	52-53	0.21	0.08	0.41	1.08	0.41	1.98
Yakima	ss	Yakima	87	C	52-58	0.11	0.03	0.19	2.55	0.67	4.49

ss = Summer steelhead

RP = Rearing pond
R = Raceway
C = Circular

Table 12. Density and Flow Indexes for 1988 Broodyear Fish reared at WDW facilities.

Location	Species	Stock	BY	Pond Type	Water Temp.	Dens. Index lb/ft3/in Avg.	Dens. Index lb/ft3/in Min.	Dens. Index lb/ft3/in Max.	Flow Index lb/gpm/in Avg.	Flow Index lb/gpm/in Min.	Flow Index lb/gpm/in Max.
Lyons Ferry	SS	Wallowa	88	RP	51-53	0.01	0.01	0.02	0.87	0.32	1.22
Lyons Ferry	SS	Lyons F.	88	RP	51-53	0.01	0.00	0.02	1.02	0.18	1.66
Ringold	SS	Ringold	88	RP	52-59	0.02	0.01	0.02	2.12	1.12	3.25
Wells	SS	Wells	88	RP	38-58	0.01	0.01	0.02	1.64	0.94	2.21
Chelan	SS	Wells	88	R	54-56	0.12	0.03	0.24	0.92	0.22	1.95
Columbia Basin	SS	Ringold	88	R	59	0.17	0.13	0.27	0.61	0.45	0.96
Columbia Basin	SS	Lyons F.	88	R	58-59	0.14	0.14	0.15	0.51	0.49	0.53
Columbia Basin	SS	Skamania	88	R	59	0.11	0.02	0.19	0.39	0.06	0.68
Lyons Ferry	SS	Wallowa	88	R	53	0.10	0.06	0.16	0.81	0.56	1.61
Lyons Ferry	SS	Lyons F.	88	R	52-53	0.11	0.04	0.21	0.90	0.44	1.41
Naches	SS	Yakima	88	R	46-58	0.32	0.13	0.53	1.09	0.51	2.10
Nelson Springs	SS	Yakima	88	R	50	0.28	0.25	0.32	1.08	0.94	1.22
Turtle Rock	SS	Ringold	88	R	36-53	0.10	0.09	0.11	0.79	0.67	0.83
Wells	SS	Wells	88	R	53	0.12	0.09	0.15	0.59	0.46	0.72
Yakima	SS	Yakima	88	C	50-58	0.12	0.06	0.18	2.23	0.95	3.08

SS= Summer Steelhead

RP = Rearing Pond
R = Raceway
C = Circular

Flow and Density Index Worksheet

Location	Species	Stock	BY	Pond Type	Water Temp.	Dens. Index lb/ft3/in Avg.	Dens. Index lb/ft3/in Min.	Dens. Index lb/ft3/in Max.	Flow Index lb/gpm/in Avg.	Flow Index lb/gpm/in Min.	Flow Index lb/gpm/in Max.
Skamania	SCT	Elochoman	88	R	40-57	0.21	0.02	0.35	1.11	0.11	1.87
	SW	Elochoman	88	R	40-57	0.23	0.07	0.35	1.21	0.37	1.89
	ss	Washougal	88	R	40-57	0.21	0.07	0.38	1.01	0.33	1.48
Vancouver	SS	Washougal	88	RP	49-53	0.01			1.76		
Cowlitz	LSW	Cowlitz	88	R	48-51	0.14	0.10	0.22	1.31	0.57	2.16
	SCT	Cowlitz	88	R	48-51	0.08	0.07	0.15	0.99	0.02	1.95
	ss	Cowlitz	88	R	48-53	0.08	0.01	0.17	0.74	0.05	1.75
	SW	Cowlitz	88	R	48-54	0.11	0.01	0.26	0.56	0.35	1.37
	SW	Cowlitz	88	RP	48-55	-			1.80	1.29	3.03
Beaver Cr.	SS	Washougal	88	R	44-58	0.18	0.06	**0.26**	**1.28**	**0.34**	**3.92**
	SCT	Elochoman	88	R	44-58	0.18	0.01	0.31	1.19	0.31	2.07
	SW	Elochoman	88	R	44-58	0.23	0.07	0.39	1.00	0.44	1.84
		Elochoman	88	RP	44-52	-			1.49	0.88	2.03

Table 13. Summary of Egg and Fry mortality for the 1988 Broodyear. at WDW Columbia River facilities.

Hatchery	Species/Stock	Starting No.	Egg Mort. No.	%	Fry Mort. No.	%	Total Mort. No.	%
Chelan 1)	SS/Wells	387,900	21,100	5.4	38,900	10.6	60,000	15.
Chelan/ Turtle Rock 1)	SS/Ringold	244,800	72,900	29.8	23,600	13.7	96,500	39.
Col.Basin/ Ringold 2)	SS/Ringold	298,200		-	34,900	11.7	34,900	11.
Lyons Ferry	SS/Lyons F.	941,800	114,700	12.2	111,800	13.5	226,500	24.
1)	SS/Wallowa	503,000	23,600	4.7	74,200	15.5	97,800	19.
Naches/ Nelson Spgs.	SS/Yakima							
Wells	SS/Wells	1,806,300	448,100	24.8	79,900	6.8	557,900	29.

1. Received as eyed eggs
2. Received as fry

Adult prespawning mortalities.

Adult prespawning mortality data from WDW hatchery reports were entered into a Lotus l-2-2-3 worksheet. Calculations were made that includes total number and percentage loss for each broodstock hatchery.

Table 14. Summary of Prespawning Mortality for the 1988-89 Broodstock.

Hatchery	Species/Stock	No. Trapped	Mortality No.	Mortality %
Beaver Creek	SW/Elochoman	1,085	NA	
	CT/Elochoman	493	NA	
Chelan	SS/Ringold	140	2	1.4
Cowlitz	SS/Cowlitz	1,313	NA	-
	SW/Cowlitz	3,237	(1) NA	-
	CT/Cowlitz	465	NA	-
Lyons Ferry	SS/Lyons Ferry	1,239	28	2.3%
Skamania	SS/Skamania	19,497	56	2.8%
Wells	SS/Wells	653		
Yakima	SS/Yakima	157	9	5.7

NA = Not Available

(1) This figure includes both run times of winter steelhead broodfish.

Table 15. Summary of Epizootics at WDW Columbia Basin Rearing Facilities; July 1, 1989 to June 30, 1990.

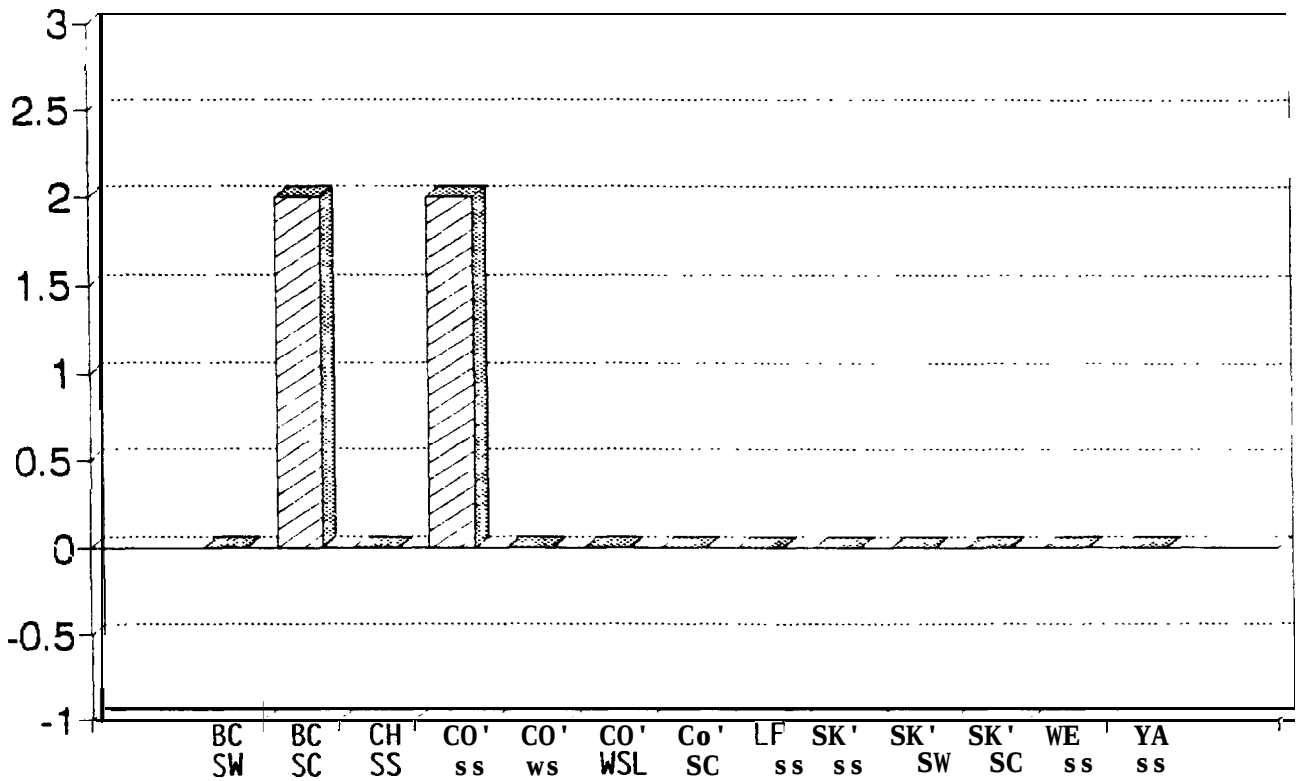
Hatchery	Date	Species	Disease	Mortality No.	Mortality %	Medication Type
Cowlitz	Chronic	SS	Ceratomyxosis	153,000	26%	None
	Chronic	SW	Ceratomyxosis	788,000	41%	None
Lyons Ferry	7/89	ss	IHN	291,000	100%	None
Skamania	7/89	SW	IHN	56,000	100%	None
	4/90	SW	IHN	167,000	63%	None
	4/90	ss	IHN	156,400	48%	None

Table 16. Feed Conversion Rates at WDW Columbia Basin Rearing Facilities for the 1987 Broodyear.

Facilities	Species/Stock	Conversion Rate
Beaver Creek	SS/Skamania	1.38
	SW/Elochoman	1.15
	CT/Elochoman	1.22
Chelan	SS/Wells	1.14
Chelan - Turtle Rock	SS/Mixed	1.12
Columbia Basin - Ringold	SS/Mixed	1.47
Cowlitz	SS/Cowlitz	1.95
	SW/Cowlitz	2.10
	SW(late)/Cowlitz	
	CT/Cowlitz	1.41
Lyons Ferry	SS/Lyons Ferry	1.11
	SS/Wallowa	1.47
Naches - Nelson Springs	SS/Yakima	1.53
Skamania	SS/Skamania	1.24
	SW/Washougal	1.24
	CT/Washougal	1.24
Vancouver	SS/Skamania	0.90
Wells	SS/Wells	1.45
Yakima	SS/Yakima	1.00

WDW - 1989 BROODSTOCK RESULTS

Renibacterium salmoninarum SURVEYS



HATCHERIES

BC = Beaver Ck. Hatchery
CH = Chelan Hatchery
CO = Cowlitz Hatchery
LF = Lyons Ferry Hatchery
SK = Skamania Hatchery
WE = Wells Hatchery
YA = Yakima Hatchery

SPECIES

SW = Steelhead Winters
SC = Searun Cutthroat
SS = Summer Steelhead
SWL = Steelhead Winter - Late Timing